MISSOURI DEPARTMENT OF TRANSPORTATION
MATERIALS ENGINEERING
Jefferson City, Missouri

Test Method
MoDOT T36
DENSITY OF PLASTIC PORTLAND CEMENT CONCRETE BY NUCLEAR GAUGE

1.0 SCOPE

1.1 This test method describes a procedure for determining a density correction factor for the nuclear gauge and for determining the in place density and the percent compaction of plastic portland cement concrete.

2.0 PRECAUTIONS

2.1 Before operating a nuclear gauge, attendance at a course on gauge operation and safety is required.

2.2 NEVER TOUCH THE SOURCE ROD WITH ANY PART OF YOUR BODY

2.3 At the end of each day's operation, remove the bottom cover plate from the nuclear gauge **PER MANUFACTURER'S INSTRUCTIONS** to assure that no concrete has been carried into the gauge.

2.4 Keep a light coat of oil and graphite on the probe, lead shield, and gauge case to prevent concrete from adhering.

3.0 APPARATUS

3.1 Scale or balance graduated in 0.01 pound, accurate within 0.3 percent of load at any point within the range of use. The range of use shall be considered to extend from the weight of the empty watertight box to the weight of the box filled with concrete weighing approximately 160 pounds per cubic foot.

3.2 Box (inside dimensions 27 inches long x 21 inches wide x 4 inches deep). Box should be constructed of steel of 0.10-inch minimum thickness and should have handles for lifting. All joints shall be welded and waterproof. The joint and top rim of the box may have to be reinforced as necessary to prevent distortion when filled with concrete. The top rim shall be smooth and plane within 0.01 inch and shall be parallel to the bottom within 0.5 degrees. The top rim is satisfactory if a 0.01-inch feeler gage cannot be inserted between the rim and the plate glass laid over the box. The top and bottom are

satisfactorily parallel if the slope between pieces of plate glass in contact with the top and bottom does not exceed one percent in any direction. Boxes built after January 1984 shall be a minimum of 24 inches long x 24 inches wide x 4 inches deep. New boxes may be constructed of other materials, except wood, so long as the requirements for waterproofing and dimension tolerances are fulfilled.

3.3 Plate glass of sufficient size to cover the box and have at least one-inch overhang on all sides.

3.4 Square point shovel (approx. 10 inches wide).

3.5 Strike-off (1/4 inch x 1 inch x 1 inch steel angle, or larger), straight and of sufficient length to strike off concrete in the box.

3.6 Calibrated thermometer, 1F increments.

3.7 Nuclear gauge, calibration standard, calibration charts, and manufacturer's instruction manual.

4.0 PROCEDURE

4.1 Nuclear Gauge Correction Factor. A correction factor shall be determined at the start of operations, after any change in materials, mix proportions, mixing pro cedures, placing procedures, as otherwise specified, or as deemed necessary by the engineer.

4.1.1 Weight the watertight box, empty, (W_B) to the nearest 0.01 pound. Weigh empty box with plate glass in place to the nearest 0.01 pound (W_{BG}).

4.1.2 Fill the box with water, determine the temperature of the water, then cover with a piece of plate glass in such a way as to eliminate bubbles and excess water. Weigh the box filled with water and plate glass in place, to the nearest 0.01 pound (W_{BGW}).

4.1.3 Calculate the volume of the box as shown in paragraph 4.1.13.

4.1.4 Empty the box of all free water, wipe with a cloth if necessary.

4.1.5 Place the box on a flat, solid level surface, preferably concrete.

4.1.6 Obtain a representative sample of concrete from the mixer discharge.

4.1.7 Fill the box in two, approximately equal layers. Consolidate each layer by thoroughly spading from end to end and then side to side, with the square point shovel. When spading the top layer, penetrate into but not through the bottom layer.

4.1.8 After spading is complete, close the spading voids by raising one end of the box approximately 3 inches and dropping it. Repeat this procedure for each end until the voids are closed (should be 4 to 6 times for each end). An internal vib rator may be used in lieu of raising and dropping the box.

4.1.9 Strike off the consolidated concrete with a screeding motion of the strike-off. Repeat if necessary to obtain a smooth, voidless surface.

4.1.10 Weigh the box full of concrete, to the nearest 0.01 pound (W_{BC}).

4.1.11 Place the nuclear gauge on the concrete approximately the same distance from all sides of the box and obtain an average density value (WD_{avg}) to the same depth as the field tests by taking four one minute counts by the procedure in paragraphs 4.2.2 through 4.2.8 of this test method.

4.1.12 Carefully remove the gauge and using a 24-inch minimum length swab, clean concrete from the source rod and bottom of the gauge. **SEE PRECAUTIONS** and Section 4.2.7 of this test method.

4.1.13 Calculate the volume of box.

$$V_B = \frac{W_{BGW} - W_{BG}}{W_S}$$

V_B = Calibrated Volume of Box, nearest 0.01 cubic foot.

W_S = Unit weight of water from following table, interpolate if neces sary

Unit Weight of Water

Temperature deg F	Pounds Per Cubic Foot
60	62.37
65	62.34
70	62.30
73.4	62.27
75	62.26
80	62.22
85	62.17

4.1.14 Calculate the density of the concrete in the box.

$$D_l = \frac{W_{BC} - W_B}{V_B}$$

D_1 = Density (unit weight) of concrete in the box to the nearest 0.1 pound per cubic foot.

W_{BC} = Weight of box full of concrete to nearest 0.01 pound.

W_B = Weight of box, nearest 0.01 pound.

V_B = Calibrated volume of box, nearest 0.01 cubic foot.

4.1.15 Calculate the nuclear correction factor.

$C = D_1 - \mathbf{WD}avg$

C = Nuclear correction factor, nearest 0.1 pound per cubic foot. It is the difference between **WDavg** and D_1. If **WDavg** is greater than D_1, the correction factor will be negative. If **WDavg** is less than D_1, the correction factor will be positive.

D_1 = Density of concrete in box to nearest 0.1 pound per cubic foot.

WDavg = Indicated nuclear density to nearest 0.1 pound per cubic foot.

4.2 Determination of In-place Density.

4.2.1 Determine Standard Density of Concrete, D_2, in accordance with AASHTO T121 except that an air meter pot may be used as a measure.

4.2.2 Obtain density standard count per manufacturer's instruction.

4.2.3 Select and record test locations immediately behind the finishing machine but prior to texturing and curing operations. Place the nuclear gauge on the plastic concrete surface at the selected location.

4.2.4 Lower the source rod. Ideally the test depth should be such that there is approximately 0.5 inch but not more than one inch of plastic concrete between the bottom of the probe and the top of the hardened concrete, i.e., for a 2 inch thick overlay lower the rod to 1 1/2 inch depth.

4.2.5 Pull the gauge slightly toward the scaler end.

4.2.6 Obtain a one minute density count.

4.2.7 Without retracting the source rod, pick the gauge up and clean concrete from the source rod and bottom of the gauge, using 24-inch minimum length swab. During

retraction of the source rod into the gauge, the cleaning ring wipes the rod clean. After the rod is retracted, wipe the bottom of the gauge clean. **SEE PRECAUTIONS**, section 2 of this test method.

4.2.8 Using a probe and ruler, determine the depth of plastic concrete at the in-place test location.

4.2.9 Read and obtain the wet density (WD) from the gauge scalar.

4.2.10 Calculate the corrected in-place density and percent of standard density.

CWD = Corrected in-place nuclear density to the nearest 0.1 pound per cubic foot.

CWD = WD + C (If C is negative, it is subtracted from WD.

W**D** = Indicated nuclear in-place density to nearest 0.1 pound per cubic foot.

C = Nuclear correction factor to the nearest 0.1 pound per cubic foot.

$$\% \text{ of Standard Density} = \frac{CWD \times 100}{D_2}$$

D_2 = Standard density of concrete to nearest 0.1 pound per cubic foot.

Calculate percent standard density to nearest 0.1 percent and round to nearest whole number for reporting.

5.0 RECORDING

5.1 Record the following information in the same field book used for recording Standard Density data:

CORRECTION FACTOR

5.1.1 Date

5.1.2 Test Number

5.1.3 Location where concrete sample was obtained (deck location where material would have been placed)

5.1.4 Calibrated volume of the box. (= V_B)

5.1.5 Weight of box (= $W_{B)}$

5.1.6 Weight of box, full of concrete (= W_{BC})

5.1.7 Density of concrete in the box. (D_1)

5.1.8 Density Standard Count.

5.1.9 Indicated Density (Average of the four WD readings). (WDavg)

5.1.10 Nuclear Correction Factor (C)

IN-PLACE DENSITY

5.1.11 Date

5.1.12 Test Number

5.1.13 Location of in-place nuclear density.

5.1.14 Depth of plastic concrete at test location.

5.1.15 Density Standard Count.

5.1.16 Indicated density (WD)

5.1.17 Corrected nuclear density (CWD)

5.1.18 Percent consolidation (% of Standard Density).

6.0 REPORT

6.1 Report items 5.1.7 through 5.1.22 from section 5 on Form C-710ND (REV).